Impact of Humic Acid Application along with Recommended Dose of Chemical Fertilizers (NPK) on Growth and Grain Yield of Wheat (*Triticum Aestivum* L.) Under Bahawalpur Conditions

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Abstract

The high cost of inorganic fertilizers and uncertainty in their availability has resulted the increased use of natural fertilizer resources for increasing crop production on sustainable basis. This experiment was conducted to determine the best dose and potential of humic acid (HA) in combination with synthetic fertilizers. The experiment was conducted under the climatic conditions of Bahawalpur to find the effect of humic acid on yield and yield components of wheat crop (*Triticum aestivum* L. cv. Juahar-16). Field experiments were conducted to study the potential of humic acid (HA) as a low-cost natural fertilizer and to determine its effect on the yield of wheat crop (Triticum aestivum L. cv. Naseer) at the research area of Regional Agricultural Research Institute (RARI), Bahawalpur during 2020-21. In this study, a control and four levels of humic acid (0, 4.0, 8.0, 12.0 and 16.0 kgha^{-1}) were applied along with recommended doses of NPK. The experimental treatments were applied in RCBD layout with three replications. All P, K and humic acid along with half N was applied at sowing while remaining half N was applied with first irrigation. Plant growth, yield parameters and yield data were recorded. Pre-sowing soil samples were collected from the field and analyzed for EC, pH, OM, Texture, P (available) and K (available). The results obtained showed that maximum yield of 5781 kgha^{-1}, 1000 grain weight (g) and spike length (cm) were obtained from T_5 (16 kgha^{-1} HA) that was at par with T_4 (12 kg ha^{-1} HA) and T_3 (8 Kg ha^{-1} HA). Hence the best dose of humic acid for wheat is T_3 (8 kgha^{-1} HA) that showed an increased yield by 3.63 times over the control under Bahawalpur conditions. Results suggested that effect of applied HA on plant growth with chemical fertilizers to soil increased grain yield of wheat from 1.5 to 5.45 times over the control. It was found that the highest yield was obtained in T_5 treatment and the second-best results were obtained with T_4 treatment, but it has a high cost, while treatment T_3 was the most significant economically and yielded high income when compared to other treatments. Hence, it has been

concluded that HA has a great potential to increase grain yield production and to improve the soil fertility on a sustainable basis.
Key Words: *Triticum aestivum*; grain yield; humic acid; chemical fertilizer; Pakistan.

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Introduction

Pakistani agricultural soils are alkaline and calcareous, having a high pH in which the availability of plant nutrients is the main impedance in boosting productivity, combined with micronutrient deficiencies, soils are low in organic matter (OM) (<1%) due to high temperature and low precipitation. So, climatic conditions, soil factors, and mineral nutrients are fundamental in the production of agricultural crops. In recent decades, the excessive use of chemical fertilizers in conventional agriculture has caused many environmental problems (Rasouli et al, 2022). These include the pollution of soil and water resources, reduced quality of food products, and disturbance of soil biological balance, which cause irreplaceable damage to the ecosystem (Melero et al, 2008). The goal of using nutrients efficiently in wheat crops now-a-days is the primary objective of agriculture, because of the detrimental environmental effects associated with improper fertilizer management and its excessive use (Van de Geijn et al., 1994). The sole use of chemical fertilizers (e.g. N, P, and K) may cause deterioration in soil physical, chemical and biological properties. The high cost of chemical fertilizer and unavailability at the time of application further aggravates the economic conditions of farmers. This calls for a search for an alternative best fertilizer source/ sources those are economical. According to Karakurt et al., 2009 humic acid (HA) is the active constituent of organic fertilizers, and its application may represent an alternative to conventional soil fertilization and a prompt source of N, especially in semi-arid conditions.

In recent decades, the over-use of chemical fertilizers has imposed many environmental challenges worldwide. Nowadays, organic fertilizers such as vermi compost and livestock manure have gained a huge interest in sustainable agricultural systems. Keeping in view the low soil fertility and OM, fertilizer is applied to crops using urea and diammonium phosphate (DAP), for nitrogen (N) and phosphorus (P), respectively. On average, a threefold increase in food crop production in Pakistan during last 30 years could be ascribed to thirteen-fold increase in fertilizer use (FAO 2004). Wheat, cotton, and paddy rice are three main crops consuming the major share of fertilizer usage, namely 36%, 14% and 10%, respectively. However, due to decline in fertilizer subsidies (N, P, and potassium (K) in 1986, 1995, and 1997, respectively), under structural adjustment and economic reform program coupled with price hike, the cost of production proportionally increased (FAO 2006), and consequently production cost increased.

Humic acid (HA) is a natural organic polymeric compound produced from soil organic matter, peat, and lignin decay. It absorbs several ions to form chelates with micronutrients, which release the ions slowly and continuously (Pang et al 2021). HA contains many carboxyls, phenolic, carbonyl, and hydroxyl chemical groups attached to aliphatic or aromatic carbons and improves the plants' stress tolerance, growth potential, seed germination speed and rate, crop quality, and yield, as well as the soils fertility and physicochemical properties such as permeability, aeration, granulation, and soil water holding capacity (Johns et al 2016). Hassan and Fahmy (2020) reported that the foliar application of HA significantly increased the yield components in chamomile. Dehsheikh et al, (2020), found that HA application increased soil organic matter content and improved basil plants' growth potential.

Materials And Methods

Field experiments were performed during the Rabi (Winter) growing season of 2020-21 at the research area of Regional Agricultural Research Institute (RARI), Bahawalpur (27.2046°N; 77.4977°E), Punjab Province, Pakistan. Before starting the experiments, soil samples were collected and analyzed for various physico-chemical properties following standard procedures. The methods used for soil analysis have been described by Winkleman et al. (1990). After soil analysis, prepared the land with recommended methods. The climate of the study area is arid.

In this trial, the soil was treated with: a non-fertilized control (T1), a crop fertilized with 4.0 (T2), 8.0 (T3), 12.0 (T4) and 16.0 (T5) kgha^{-1}were applied along with recommended rate of NPK (150-120-60). These rates were applied to the experimental plots at sowing time. The HA was thoroughly mixed with soil and then broadcasted as fertilizer. Here Fertilizers used as the source of N was Urea, source of P was Diammonium Phosphate (DAP) and source of K was Sulphate of Potash. The experiment was laid out in randomized complete block design with three replications. Each plot had an area of 33.81 m^2 (9 m long, 3.7 m wide), rows spacing ~ 30 cm. Prior to seeding, the rotavator was used in all treatments to prepare the uniform seed bed for better seed germination. The wheat variety Juahar-16 was sown @ 120 kg ha^{-1} on 06-11-2019. Standard cultural practices were applied constantly and uniformly through all plots. Weeding was done manually during the growing season. Weeds were controlled chemically by spraying broad and narrow leaved weedicides. Fluroxpyr 9.7% MCPA 38.8% named as Starne M (300 ml acre^{-1}) was sprayed after 45 days after sowing to control the broad leaf weeds while the mesosulfuron-methyl 3.0 %w/w named as Atlantis 3.6 WG (160 g acre^{-1}) was used for narrow leaf weeds after 56 days of sowing. Intercultural operations such as thinning, weeding, re-sowing, drainage, irrigation and plant protection measures were taken as and when necessary and kept usual and uniform for all the experimental plots. The crop was harvested at physiological maturity. Data on yield components and grain yield from all treatments were obtained on the four central rows in each plot. At physiological maturity data regarding agronomic traits as number of fertile tillers, plant height, number of spikelets per spike, number of grains per spike. Plant height were recorded by measuring height of ten randomly selected tiller from ground level to the tip of spike with the help of meter rod and then calculated mean from the average. Number of grain Spike^{-1} and number of spikelets Spike^{-1} was recorded by counting of grain and spiklets of randomly ten Selected spikes.

After harvesting, 1000–grain weight (g), grain yield (kg ha^{-1}), were recorded by using standard procedures. Twenty plants were selected from each treatment and took plant height, number of spikelets per spike, number of grains per spike was recorded and values were averged to obtain mean for each parameter. A sample of 1000 seeds was taken randomly from the total seed lot of each plot and then weighed using the triple beam balance. Selected three locations of one-meter square in each plot randomly at the stage of physiological maturity, counted the total number of productive tiller and then average was calculated. Grain yield was recorded by harvesting m^{-2} per plot. Grains were threshed and weighed manually. Grain yield was then converted to get the final grain yield in Kg ha^{-1}. Calculated Grain yield data regarding square meter was then converted into the final grain yield in Kg ha^{-1}. Statistical analysis was performed using the Statistix 8.1 (2003) software application. Collected Data were subjected to analysis of variance (ANOVA) to compare the effects of HA treatments. The means were separated using Fisher's LSD (Williams et al, 2010) test at the 5% level of significance.

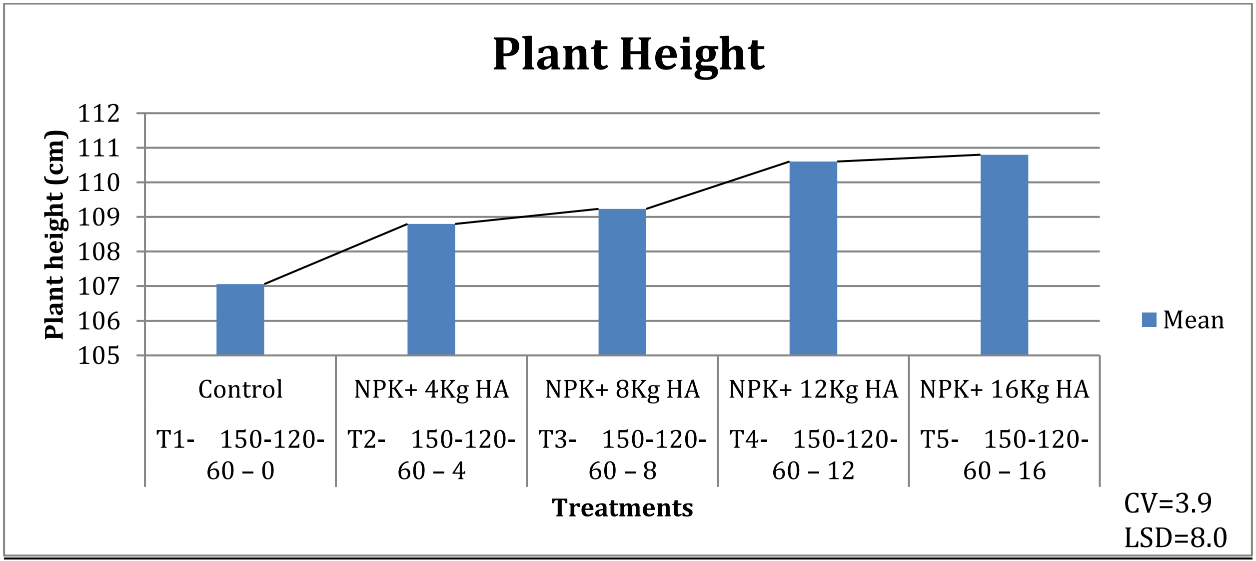
Table 1.0: Physicochemical Soils Properties collected from different experimental areas.

Parameters	Value
pH (1:1)	8.1
Organic matter (%)	0.51
EC, (1:10) (dS m^{-1})	3.1
P (Olsen's, mg kg^{-1})	6.1
K (mg kg^{-1})	110
Saturation percentage	32
Textural class	Loam

Results And Discussion

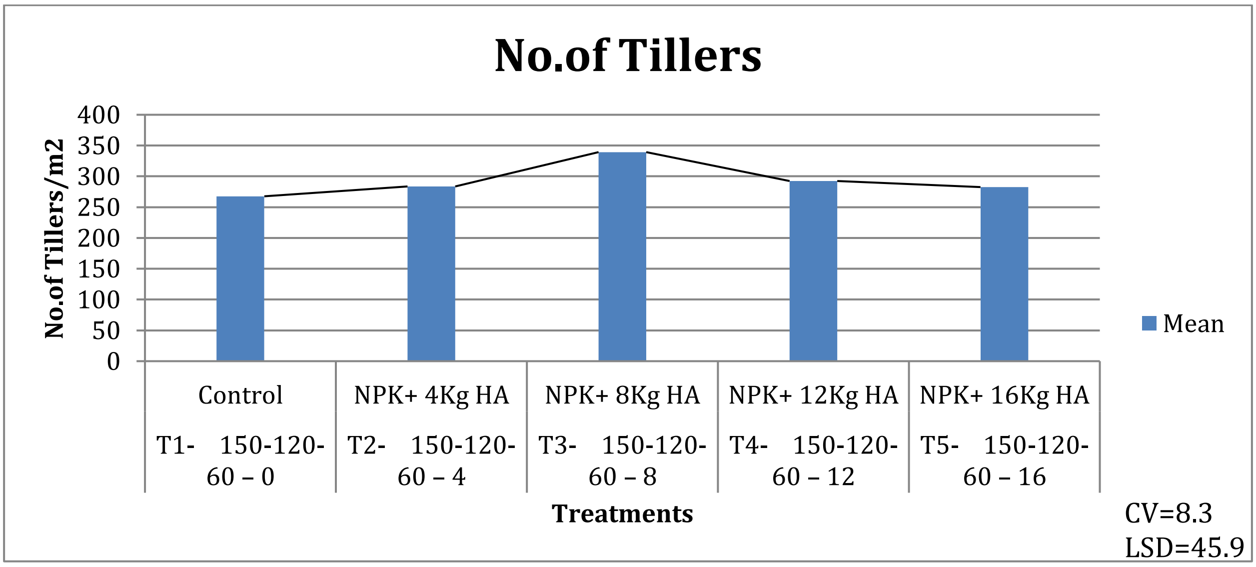
Plant Height

The results revealed that different levels of HA along with Recommended dose of chemical fertilizers significantly ($P<0.05$) affected the plant height of the crop as compared with the control (Table 2). The maximum increase in plant height (110.8 cm) was recorded in plots that received 16 kg HA. This treatment was at par with T4 followed by T3, yielding plant heights of 110.6 and 109.23 cm, respectively. However, there were non-significant ($P>0.05$) differences between these two treatments of HA. The minimum plant height (i.e. 107.06cm) was recorded in control plot(Table2). These results suggest that HA application has a stimulating effect on shoot growth (Daneshvar Hakimi Maibodi `et al, 2015).



Number of Tillers per Plant

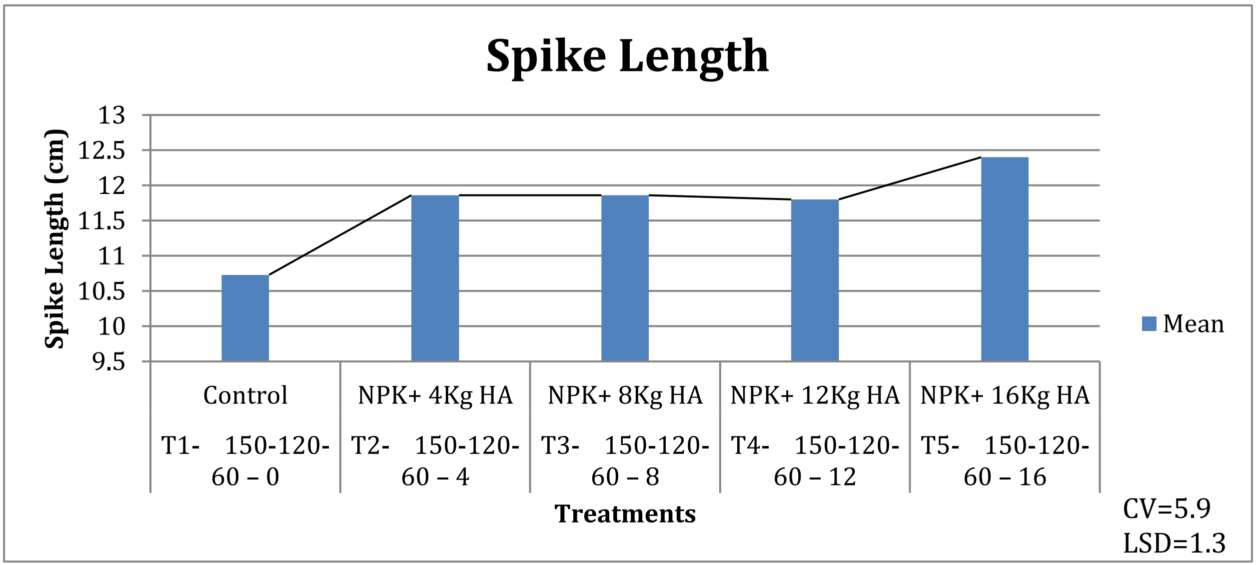
The results showed an increase in number of tillers per plant among all treatments except in the control plots (Table 2). Recorded data showed that application of 8 kg ha^{-1} HA along with Recommended dose of NPK chemical fertilizer produced the maximum number of tillers (i.e. 339.33). These results appeared to be at par with the highest (12 kg ha^{-1}) rate of HA along with Recommended dose of NPK chemical fertilizers. However, the results further showed that there were non-significant differences among all other treatments of HA.



Spike Length

The results for spike length ranged from 10.73 to 12.40 cm in this trial (Table 2). The length of spike increased in plots that received a full rate of HA i.e 16 kg ha^{-1} with recommended rate of chemical fertilize, which appeared at par with HA applied @ 12 kg ha-1 combined with

NPK recommended dose chemical fertilizers. The control plots recorded the lowest spike length.

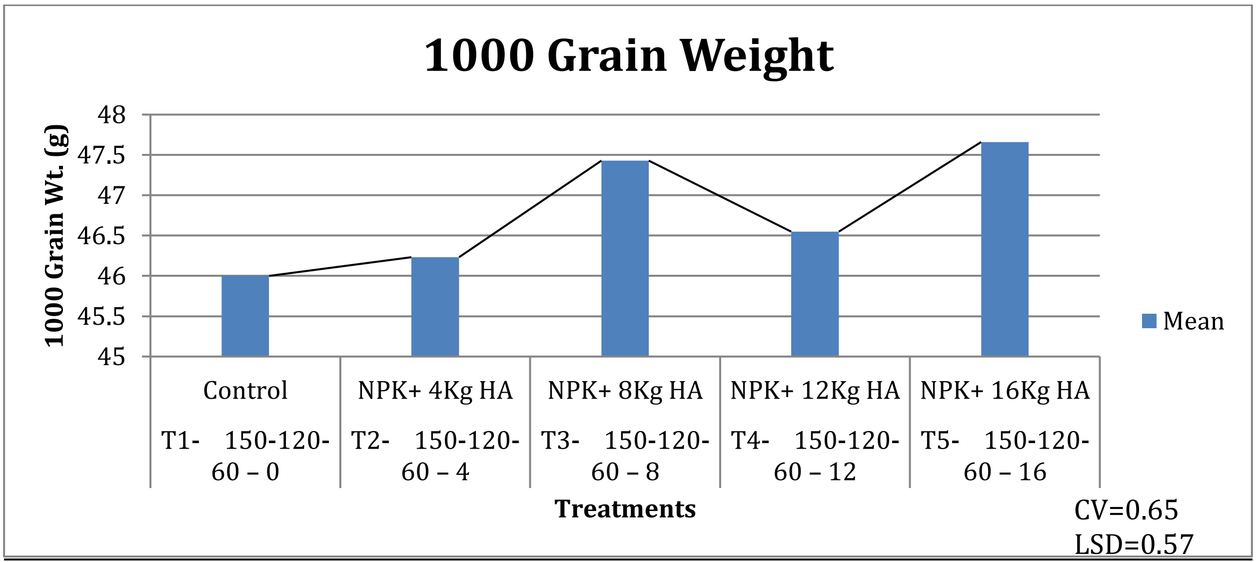


1000-grain Weight

The 1000-grain weight was significantly ($P<0.05$) affected by different treatments (Table 2). The grain weight was overall significantly higher in the second growing season than in the first. The 1000-grain weight ranged from 46g to 47.66g. The maximum (47.66g) 1000-grain weight was recorded in the treatment that received 16 kg ha^{-1} along with recommended dose of NPK; this did not differ significantly with the treatment of HA (T3 and T4) at by producing 47.43g to 46.55g 1000-grain weight, respectively. The lowest(46.0g) 1000-grain weight was recorded in control treatments and the plots, where the lowest rate of 4 kg ha^{-1} HA was applied. Similarly, Khan et al. (2010) found that humic substances increased the dry matter contents of wheat.

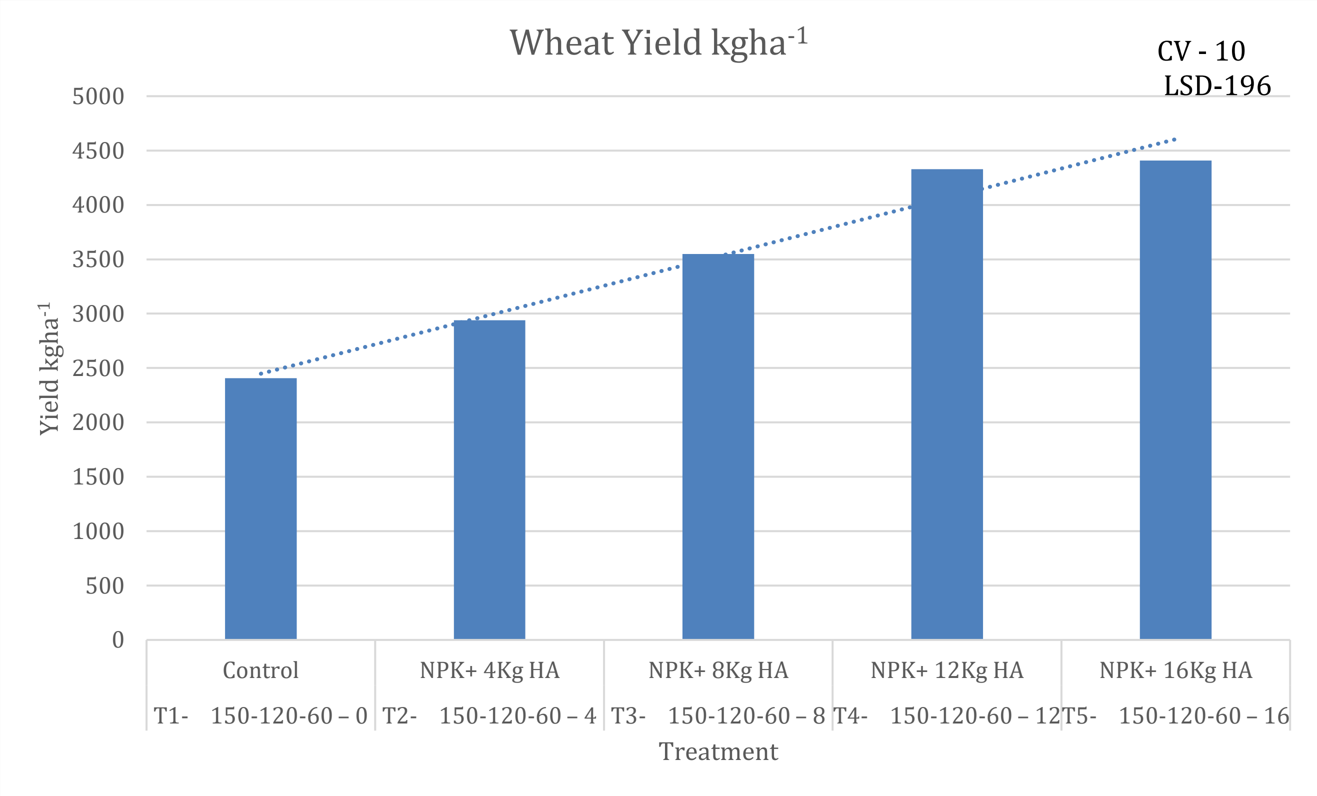
<u>Table: 2.0 Effect of Humic Acid on Yield and Yield Parameters of wheat</u>

Treatment Plan		1000 grain Weight	Plant Height (cm)	Spike Length (cm)	No. of Tillers m^{-2}	Yield ($kgha^{-1}$)
T_1 (150-120-60–0)	Control	46.00	107.06	10.73	267.66	2407c
T_2 (150-120-60–4)	NPK + 4 kg HA	46.23	108.80	11.86	283.66	2941bc
T_3 (150-120-60–8)	NPK + 8 kg HA	47.43	108.66	11.86	339.33	3548b
T_4 (150-120-60–12)	NPK + 12 kg HA	46.55	110.93	11.80	292.66	4328a
T_5 (150-120-60–16)	NPK + 16 kg HA	47.66	106.20	12.40	282.33	4408a



Grain Yield

In wheat grain yield was significantly($P<0.05$) increased by application of HA and NPK chemical fertilizers compared with control treatment in this experiment. The grain yield ranged from 5481.7 to 5780.7 kg ha^{-1}. The maximum (4408 kg ha^{-1}) grain yield was obtained from the treatment with 16 kg ha^{-1} HA + Standard dose of NPK (Table 2). These results are in line with Benedetti et al. (1996), who studied the effects of HA application alone and mixed with compound mineral fertilizer (NPK-HA) on growing lettuce and maize in the field and pots. The production of both crops was increased by the NPK-HA treatment, which was higher than Control. The second highest grain yield (i.e. 4328 kgha^{-1}) was obtained from a T4 (12) kg ha^{-1} recommended rate of NPK chemical fertilizer, while the lowest grain yield (2407 kgha^{-1} and 2941 kgha^{-1}) was noted in control plots and 4 kg ha^{-1} HA treatments, respectively (Table 2). These results might be due to the positive effect of these HA treatments on the yield components of wheat as described earlier. Ahmad et al 2018, who studied the effects of HA application increased the production of wheat by the NPK-HA treatment, which was higher than Control. Hai and Mir (1998) reported an 8% to 44% increase in yield of different crops with the application of HA in different ecological zones of Pakistan. Similarly, Sharif et al. (2002) found significant increase of 20-69% wheat yield over control under field conditions. According to Table (2) It was found that the highest yield was obtained in T_5 treatment and the second-best results were obtained with T_4 treatment. These results have also been reported by Hayes & Wilson, (1997); Padem et al., (1997); Atiyeh et al., (2002); Zandonadi et al., (2007) that Humic acids (HAs) increase growth and yields of various crops including vegetables. The same results were also depicted by Chen & Aviad, (1990); Zandonadi et al., (2007) that the characteristic growth-response curves as a consequence of exposing plants to humic substances display progressively increased growth with increasing concentrations of humic substances.



Conclusion

It is therefore concluded that effect of the applied HA on plant growth with chemical fertilizers to soil increased grain yield of wheat 1.5 to 5.45 times over the control. It was found that highest yield was obtained in T_5 treatment and the second-best results were obtained with T_4 treatment, but has a high cost, while treatment T_3 was the most significant economical and yielded a high income when compared to other treatments. So, HA has a great potential to increase grain yield production and to improve the soil fertility on a sustainable basis.

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